NOTES ON THE MORPHOLOGY AND BIOLOGY OF A NEW SPECIES OF TABANUS (DIPTERA, TABANIDAE).

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(Fifteen Text-figures.)

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Introduction.

This new species was found on sandy ocean beaches near Narooma on the south coast of New South Wales. Adult flies were first taken on Mystery Bay beach in January, 1937; others were taken on the same beach in January, 1938, when also a pupa was found emerging from damp sand at about 3.15 p.m., from which the fly emerged about fifteen minutes later. The part of the beach from which the pupa emerged had been covered by water at high tide between 6 and 8 o'clock that morning. A week later another fly was found emerging from its pupa in the damp sand. Altogether five pupae were found, and of these, two died and three adults emerged. A search was made for empty pupal cases and many were found on this beach and on others near Narooma.

In November, 1938, during a search for the immature stages of an Apiocerid (Proc. Linn. Soc. N.S.W., lxxi, p. 296), ten large Tabanid larvae were found, one large larva was found dead on the surface of the sand, and six larval exuviae were found in the sand. Of these larvae five pupated, but only two adults emerged, both females. One pupated on 24th November and emerged on 15th December, 1938 (21 days); the other pupated on 19th or 20th December and emerged on 2nd January, 1939 (13 or 14 days). Fourteen pupae were found in the sand, and of these, eight died and six emerged. Another pupa found was deformed and from it many small nematodes emerged. Larvae and pupae were more numerous about the level of high-water mark than farther back on the beach; no search was made in the sand near low-water mark because of the difficulty of sifting the wetter sand. The depth at which larvae occurred was not determined, as none were found in position, but all sand sifted was taken from between two and about ten inches from the surface, the top two inches of sand being cleared away before sifting was commenced.

Adult flies were numerous on the beach in January, many were to be seen resting on the sand in the sun, mating pairs were seen and one pair was caught. No egg-laying was observed nor were eggs or young larvae obtained. All larvae found were large, probably last instar. The flies were not troublesome on the beach, but men who had been fishing on headlands near by said they had been bitten by similar flies; however, this is inconclusive evidence, as no biting specimens were procured.

The adult was identified tentatively by Mr. G. H. Hardy as being near to *Tabanus rubricallosus* Ric. (1914) from New Caledonia, so specimens were sent to Mr. H. Oldroyd at the British Museum for comparison with the type and paratype, and to Dr. Bequaert at Harvard, who has specimens from New Caledonia. Mr. Oldroyd instanced a number of small differences between the flies from Narooma and the type series of *T. rubricallosus*, but he also considered that the close resemblance between these two littoral forms should be emphasized. Dr. Bequaert instanced a number of differences, sufficient, he considered, to constitute a separate species. The most striking differences are:

1. The presence of erect hairs on the subcallus; no trace of these is to be detected in his two females of *T. rubricallosus*.

2. The eyes in both sexes are decidedly pilose all over, the hairs being readily seen with a hand lens. In *T. rubricallosus* females the hairs are extremely sparse and short and not to be seen with a hand lens.

3. The basal (or anterior) bare area and callus of the frons is very extensive, occupying slightly over half the length, whereas in *T. rubricallosus* this bare area extends only over about one-third of the frons. Also the lower margin of the callus is only slightly convex, much less so than in *T. rubricallosus*.

4. The antennae are more thickset in the New South Wales species.

5. The New South Wales species is more hairy than *T. rubricallosus*; for instance, the upper part of the frons has many long black hairs; in *T. rubricallosus* such hairs are few and very short.

There are no males of *T. rubricallosus* in the other collections for comparison.

No precise locality was given by Miss Ricardo for *T. rubricallosus*, but Dr. Bequaert had been told by the collector that one of his specimens was caught on a beach at Lebris.

Tabanus orarius, n. sp.

In Hardy's key to species of Tabanus with hairy eyes (1939) this new species runs down to the first part of couplet three and falls into the *regisgeorgii* group; group characters are: frons diverging towards the antennae, and thorax with well-defined dark stripes, four anteriorly and three posteriorly. Included in the group are the species *T. regisgeorgii* Macquart with synonyms *T. spadix* Taylor and *T. brisbanensis* Taylor, and the species *T. diemeniensis* Ferg. These are of a general brownish colour. The new species can be very easily distinguished from them by the general grey colour and the more extensive bare area and callus of the frons.

Description.

ADULT.

A medium-sized, grey, hairy species with a large frontal callus.

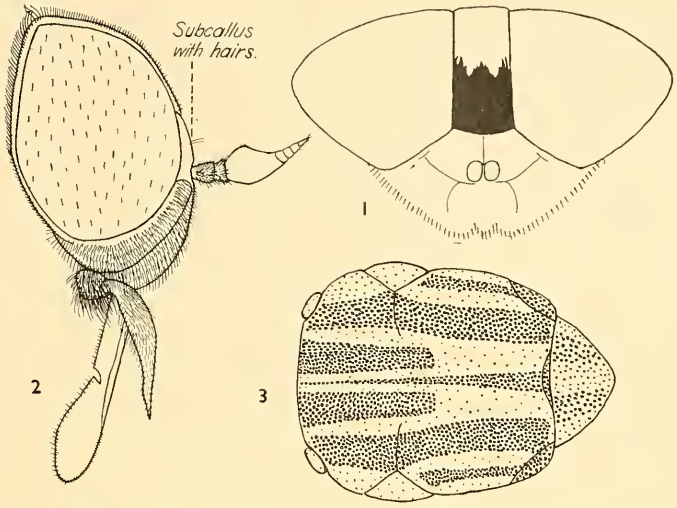
Female.

Length 13 mm., width across head 5 mm., length of wing 12 mm.

Head: Eyes sparsely covered with fine short hairs of an indeterminate colour and which can be seen with a hand lens. Behind the eyes is a fringe of erect silvery hairs. Frons with sides almost parallel, very slightly wider anteriorly, twice as long as wide, posterior half clothed with white tomentum and dark brown hairs which are longer on the vertex. Bare area and callus large (Text-fig. 1), extending back half the length of the frons and reaching the eyes for almost its whole length, lower margin very slightly convex and posterior margin irregular, shining chestnut brown in colour, lower centre bare, the rest with sparse hairs, mostly brown. Subcallus with white tomentum except on narrow median groove, and with a small patch of erect fine white hairs on each side (Text-fig. 2). Antennae (Text-fig. 2), length 1·5 mm., first segment with light olive-grey tomentum and clothed with short hairs, mainly black on dorsal half and mainly white on ventral half; second segment with some grey tomentum and short hairs mostly black, a few white on ventral surface; third segment broad, clove brown in colour, with some very short recumbent metallic pubescence. Face not sunken, covered with white tomentum and fine silvery-white hairs, beard long and white. Palpi long (Text-fig. 2), extending past the middle of the proboscis, first segment short and bulbous, second long and tapering to a point, both segments ochraceous-buff in colour, clothed with fine silvery white hairs, and on the second segment a very few black hairs also.

Thorax: Dorsum with tomentum in longitudinal stripes of iron-grey or dark olive-grey alternating with light olive-grey (Text-fig. 3), four main anterior and three main posterior dark stripes; median stripe very fine anteriorly, short lateral posterior stripes partly obscured by a fold in the dorsum on each side. The whole dorsum clothed with erect fine silvery hairs and coarse black hairs, together with recumbent bronze, and some recumbent black, hairs. Long silvery white hairs form a fringe

above the base of the wings and on the edge of the scutellum. The notapleura have cinnamon drab tomentum and very long hairs, fine silvery white and coarse black. The ventral surface is covered with tomentum, mostly olive-grey, and densely clothed with long silvery white hairs.



Text-figs. 1-3. *Tabanus orarius*, n. sp.
1. Head of female, front view, × 8. 2. Head of female, side view, × 10 approx.
3. Dorsum of thorax, × 8.

Legs: All coxae and femora covered with olive-grey tomentum and fine silvery white hairs, except on the inner edge of the fore femora, where the hairs are short and dark; and on the distal ends of all femora which are bare of tomentum, tawny in colour, with a few long black hairs. Fore tibiae russet, mid tibiae tawny, on proximal three-fourths, with many silvery hairs and some black hairs, the distal fourth and the tarsi mummy brown in colour with short hairs, mainly black. Hind tibiae russet with black hairs in a line along mid-dorsal surface and covering apex; and with a very noticeable fringe of long hairs along edges, on inner edge silver hairs only, except at distal end, where they are short and nearly all black, on outer edge silver with one or two black hairs on the proximal half, then black and silver mixed on the distal half. Hind tarsi mummy brown with short hairs mainly black.

Wings: Clear, veins hazel brown, appendix short, stigma inconspicuous.

Abdomen: Dorsal surface covered with tomentum, mostly light olive-grey toning into light cinnamon drab on posterior and lateral edges of segments 3 to 6. Silvery white hairs cover most of the first segment and the lateral edges of all segments; they occur on the posterior edges of segments 2, 3 and 4; and also form a small triangular patch in the centre of segments 2 to 5; these patches form a median longitudinal stripe; elsewhere the surface is clothed with short black hairs. The ventral surface is covered with tomentum, pinkish buff on lateral and posterior edges of all segments except the first, elsewhere light olive-grey, with short silvery hairs on all segments and many black hairs also on the seventh segment.

In the female paratypes the colour of the callus varies from hazel brown to almost black, and the colour of the legs varies correspondingly. The labial palpi are deformed in one specimen. The cinnamon tinge in the tomentum is more evident in some specimens than in others, and the dark transverse bars on the abdomen, as described in the male type, are very evident in some of the female paratypes. The appendix in the wing varies in length from 0·3 mm. to little more than a sharp angle on the vein. The wings are damaged in most of the bred specimens. Neave (1915) states "it is really more difficult to obtain perfect specimens of Tabanidae from bred

individuals than from collected ones", for "Flight seems invariably to take place before the wings are completely hard and dry".

Male.

Length, 15·5 mm., width across head, 6 mm., length of wing, 11 mm.

Head: Eyes with large facets hazel brown in pinned specimens and densely covered with bronze hairs; small facets fuscous in colour and sparsely covered with shorter hairs. Subcallus with white tomentum except on median groove and in angle between eyes, where it is bare of tomentum and is fawn in colour, there is a small patch of hairs on each side, the hairs are shorter and finer than in the female. Antennae not as broad as in female. Face sunken, same covering as in female. Palpi with first segment about the same width as the second and more than half as long; second segment has rounded end; the first segment is light olive-grey at base, the rest of the segment and the second light ochraceous buff in colour and clothed as in the female.

Thorax: As in female except that recumbent hairs are very sparse and the erect hairs are longer.

Abdomen: On dorsal surface the anterior border of segments 3 to 5 is bare of tomentum, and the dark surface with black hairs forms almost black transverse bars. The hairs are longer except on the median triangular patches, where the silvery hairs are shorter and sparser, so the central stripe is a little less evident than in the female.

In one male paratype there are no hairs on the subcallus; in the other the dark transverse bars on the abdomen are less evident than in the type.

The colours in this description have been identified as accurately as possible with the aid of Ridgeway's colour chart (1912), a binocular microscope with artificial light being used to examine the colours of the specimens.

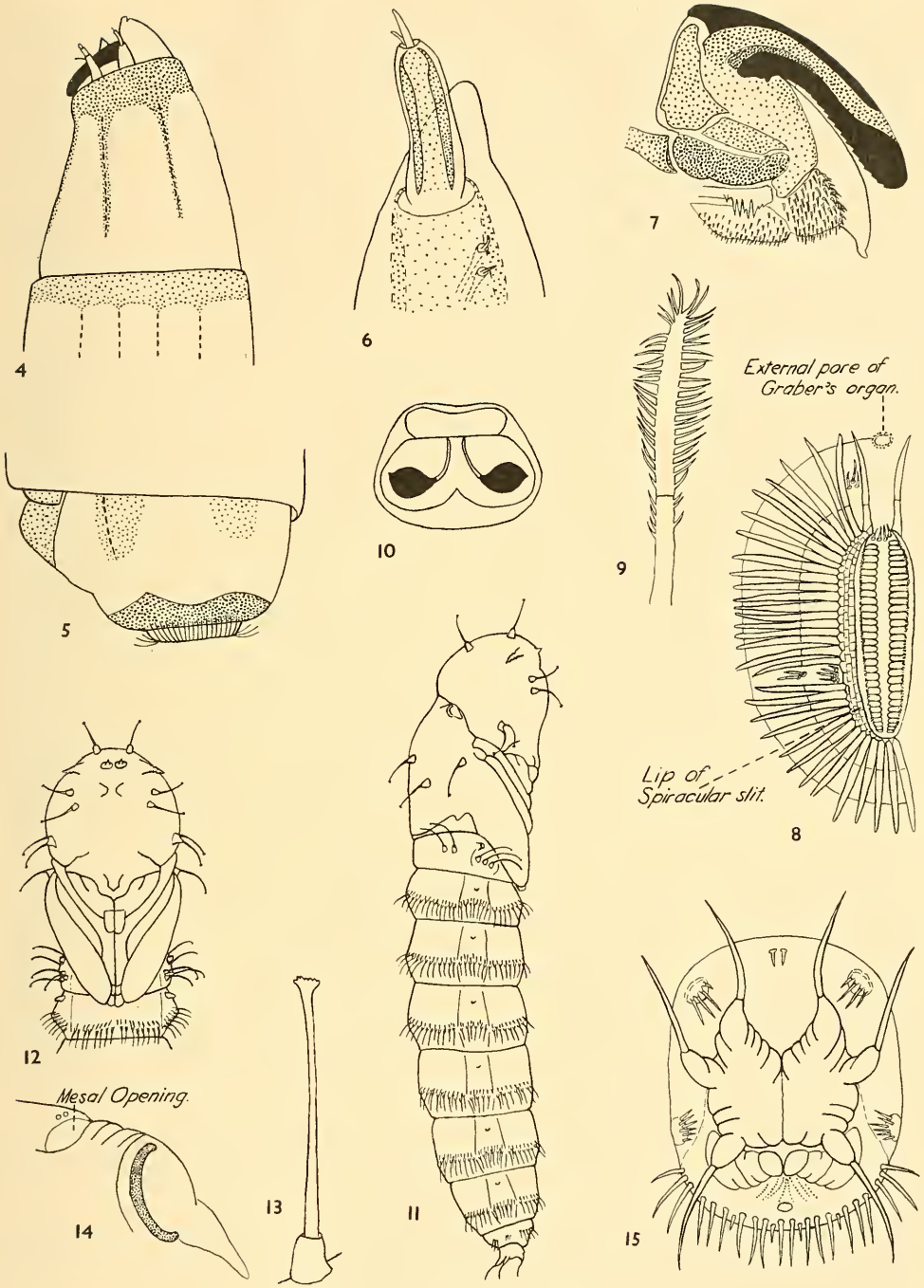
LARVA (Text-figs. 4–10).

The larva is white in colour, the skin striated, shining, and transparent enough for the internal organs to be seen. A live larva when quiescent measured 22 mm. in length and 4 mm. in breadth; when active the larva extended up to about 28 mm. At the anterior end (Text-fig. 4) the larva tapers gradually to the small head; at the posterior end it tapers only slightly and the last segment (Text-fig. 5) is abruptly truncated.

Head: The head capsule measures up to 5 mm. in length and about 1 mm. in width, it is mainly cream in colour with some light brown portions and very dark brown mandibles. The eye-spots are small. Various parts of the head of Tabanid larvae have been described in detail by Boving (Webb and Wells) 1924, Stammer 1924, Cameron 1934, and Fuller 1937, and these authors differ somewhat in naming parts.

The antennae (Text-fig. 6) are two segmented, the first segment is long and cylindrical in shape, the apical segment is much shorter, it is slender and tapers to a rounded point, and at its base is a very short and slender branch. Each antenna arises from near the end of a structure called by Cameron (1934) "a flattened cephalic sclerite", and by Fuller (1937) "an elongated plate of the lateralia", this structure is considered by Boving (Webb and Wells 1934) to be the basal segment of the antenna, which he describes, therefore, as three-segmented. Philip (1931) devotes a paragraph of "Special Comment" to this question. Situated just behind the antenna on the lateralia are two minute structures, probably sense organs.

Mouth-parts (Text-fig. 7): The heavily chitinized mandibles agree in general with the descriptions of other writers. The maxillae differ in shape from that figured by Fuller (1937), but resemble the one figured by Boving (Webb and Wells 1934) and called by him "the proximal part of the mandible". The maxillary palpi are three segmented, the basal segment is long, thick at the base and tapering distally; towards its anterior end on the ventral surface there is a side growth bearing a long hair. The middle segment is short and thick, the distal segment is about the same length but more slender, and it bears sensory papillae at the tip.



Text-figs. 4-15. *Tabanus orarius*, n. sp.

4. Anterior end of larva, lateral view, × 16 approx. 5. Posterior end of larva, lateral view, × 16 approx. 6. Antenna of larva, × 130 approx. 7. Mandible and maxilla of larva, × 50 approx. 8. Posterior spiracle of larva (with fringe shown on one side only, and filament branches omitted), × 50 approx. 9. Branched filament of spiracular fringe, × 135. 10. Anterior portion of Graber's organ, × 150 approx. 11. Pupa, lateral view, × 5. 12. Anterior end of pupa, ventral view, × 5. 13. Orbital seta of pupa, × 25. 14. Thoracic spiracle of pupa, × 50 approx. 15. Posterior segment of male pupa, end view, × 20 approx.

Thorax: The prothorax is encircled anteriorly by pale brown unstriated skin densely covered with minute hairs or spines; this hirsute skin covers the anterior retractile portion of the prothorax and forms a broad collar on the non-retractile portion (Text-fig. 4); running back from it for more than two-thirds the length of the segment are five projections, paired laterals and a single ventral one. At the anterior edge of both meso- and meta-thorax is a band of hirsute skin, much lighter in colour than on the prothorax, and on these are small backwardly directed projections situated at the lateral furrows, along which the hirsute skin is continued in broken lines. On the ventral surface of each thoracic segment are two groups of fine hairs, one group on each side of the middle line, five or six hairs in each group. Spiracular openings occur on the prothorax near the posterior edge, and on the meta-thorax in the hirsute band at the anterior edge of the segment. The actual evagination of the anterior spiracles during the prepupal stage described by Philip (1931) and Cameron (1934) was not observed.

Abdomen: At the anterior border of segments one to seven are pseudopodial circlets, each composed of four pairs of retractile prolegs; the ventral, latero-ventral and lateral pairs are more or less rounded and prominent, the dorsal pair is only slightly raised and is more or less elongated. In conjunction with these locomotor swellings are more or less complete bands of hirsute skin. On the posterior border of segment seven there is a wide complete band of hirsute skin, which is hidden when the larva contracts. On segment eight brown hirsute skin forms a wide collar round the spiracular prominence; it covers the ridges round the anus and forms two irregularly shaped patches on each side of the segment. Between the ventral pseudopods on segments one to seven is a pair of fine hairs, one on each side of the middle line. Isolated single fine hairs occur also on the thorax and abdomen. There are very small spiracular openings on segments one to seven, posterior to the lower edge of the lateral pseudopods. Very slender tracheae were found connected to some of these openings in the last larval exuviae, the only stage secured. Philip (1931) states "close observation during the act of moulting reveals that tracheal filaments are cast loose laterally on every segment except the prothoracic and anal". The posterior spiracle (Text-fig. 8) is situated on the last segment on an oval area surrounded by a thickened collar. It has the felt chamber and antechamber depicted by Stammer (1924). The visible part of the spiracle is in the form of a pair of vertical chitinous ridges each crossed by a series of bars of thicker chitin, as depicted by Stammer (1924) and described by Fuller (1937); this external part and the felt chambers are orange-coloured. The lips of the spiracular slit can be drawn over the chitinous ridges of the spiracle and so close the antechambers leading to the trachea. A little back from the edge of the spiracular slit is a fringe of branched filaments (Text-figs. 8 and 9); these are long enough to extend across the oval area and on to the hirsute skin of the surrounding collar, and in some preserved specimens this fringe can be seen standing out just beyond the end of the segment with magnification as low as ten. A group of four setae is situated at the dorsal end of the chitinous ridges, and other groups occur on the surrounding area.

Graber's organ (Text-fig. 10). This organ was not observed in living specimens, as the larvae had been killed and preserved before close examination was possible. In the preserved specimens, all large, probably last instar, two black bodies only were found; and similarly two black bodies were found in the last larval exuviae, in the posterior section of the tube cast off from Graber's organ. The external opening of this tube can be seen in mounted exuviae (Text-fig. 8); it lies above the spiracle in the fold between the oval area and the hirsute collar.

PUPA (Text-figs. 11–15).

Pupae vary in length from 18 to 20 mm., and the largest was 4 mm. in width across the thorax.

The head and thorax (Text-figs. 11 and 12) are armed with long slender setae (Text-fig. 13), the ends of which are expanded, and on the distal surface have a

minutely branched coral-like structure. A central canal runs the length of each seta, and all setae are borne on prominent tubercles. There is a pair of frontal setae, a pair of anterior and a pair of posterior orbital setae, and on each side there is a large lateral orbital tubercle bearing two setae. On the dorsal surface there is a pair of vertical setae and a pair each of anterior and of posterior meso-notal setae. Laterally there is a pair of basal alar setae. The nomenclature of the setae is that used by Cameron (1934).

There are no setae on the meta-thorax. The thoracic spiracle is prominent (Text-fig. 14), and the mesal opening is large, with a pair of minute openings on the dorsal edge.

The wing sheaths extend to the second abdominal segment.

There are eight abdominal segments. On the first there are two tergal and three pleural setae on each side; they are long and slender and the ends are only slightly expanded; they are each borne on a very small tubercle. On pupal exuviae the expanded ends have usually been broken off the setae on the first abdominal segment, and sometimes off the thoracic setae also. Segments 1 to 7 each bear laterally a pair of small spiracles on low backwardly directed elevations. Segments 2 to 7 are divided by longitudinal lines into dorsal, ventral, and paired lateral regions. These segments each bear a girdle of spines on the posterior half, the girdle is formed by a posterior series of mostly long spines, and an irregular anterior series of mostly short spines, but there is considerable variation in the lengths of the spines in both series. The spines become more numerous and slightly longer on each segment as they progress backwards. The last segment terminates in an aster (Text-fig. 15) of paired tubercles each bearing a long slender spine. In male pupae there is a large anal tubercle with a continuous row of spines beneath it, and in the dorso-lateral comb the number of spines varies from three to five, usually there are three long and one or two short spines, and in the dorsal comb there are only two short spines. In the female pupae the anal tubercle is small and there is a wide median gap in the row of spines beneath it, the spines in the dorso-lateral comb are usually longer and more numerous than in the male (as many as seven occurred in one specimen), and the spines in the dorsal comb are longer and may be four or five in number.

Types and Distribution.

Types: Holotype female, allotype male with pupal exuvia, morphotype pupae (male and female) and larva; six female paratypes (one with larval and pupal exuviae, three with pupal exuviae) and one male paratype with pupal exuvia. These, together with slides used in the prepration of this paper have been placed in the Macleay Museum at the University of Sydney. Paratypes male and female have been placed in the School of Public Health and Tropical Medicine, Sydney, and in the C.S.I.R. Museum at Canberra. Specimens were sent to the British Museum and to the Museum of Comparative Zoology at Harvard University.

Type locality: Narooma, N.S.W.

Distribution: In the collection at the Macleay Museum there are two females from Sydney, N.S.W., and three from Rockhampton, Queensland.

Conclusion.

Three records have been found of Tabanid larvae in beach sand. Surcouf, in Wytsman's Genera Insectorum (1921), refers to the finding in sand on the coast of Brittany of a larva which developed into an adult identified as *T. nigrifacies* Gobert, later included by Szilady in the sub-genus *Ochrops*. Again in 1922 Surcouf records the finding of a hundred Taon larvae in damp sand on the shore in Tunisia, and some more in Algiers; adults obtained from these larvae were described as a new species, *Ochrops seurati*. Spencer (1942) records the finding of a larva on the sea shore in British Columbia from which was obtained a Tabanid identified as a new species of *Hybonitra*. Unfortunately no description of any of these larvae has been found.

In the larva of *T. orarius* are two features, the striated dorsum of the thorax and the abruptly truncated posterior segment, which occur also in *T. froggati*, *T. gentilis* and *T. neobasilis* described by Fuller (1937), who states "all other species described have the thoracic segments unstriated on the dorsum" and "all other *Tabanus* larvae described are pointed posteriorly, most having long siphons".

Also in this larva the fringe round the posterior spiracle, and in the pupa the length, and expanded ends, of the cephalothoracic setae are characters that have not been found in descriptions of other Tabanidae.

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